Chapter 14
Biofiltration (Vapor)

14.1 General.

The process of biofiltration and its applications are described in the chapter's first section. The second portion of the chapter is a hazard analysis with controls and control points listed.

14-2. Technology Description.

a. Process.

Biofiltration uses biodegradation to treat air stream contaminants (volatile organic compounds [VOCs]) prior to releasing the stream to the atmosphere. It can be viewed as a self-renewing adsorption bed. The VOC-laden vapor is passed over a porous bed of high surface area packing that serves both as a support surface for the appropriate microbes and as an adsorbent surface for the VOC. This increases the retention time of the VOC in the bed and permits the microbes more time to degrade organic compounds. The air contaminants are solubilized and in turn are degraded by the microbes. Materials that can serve as packing include sand, activated carbon, ceramic supports, peat moss, wood chips, and glass and plastic beads. As this is a destructive process, the unit operating cost is usually less than adsorbent regeneration processes such as activated carbon. Nutrients and water may be added by spraying across the top surface of the bed. If water is not added, the entering air stream must be humidified to prevent the bed from drying out (which will inhibit microbial activity). Specifically cultured organisms may be used in an effort to shorten the acclimation time at the start of operations. The biofiltration process is illustrated in Figure 14-1.

b. Applications.

The technology is best suited to steady-flow streams where the VOC composition and concentration changes slowly if at all. The bed will generally not keep the exhaust air stream in compliance during periods of shock loading since the microbes require time to grow and adapt to different concentrations of substrate.

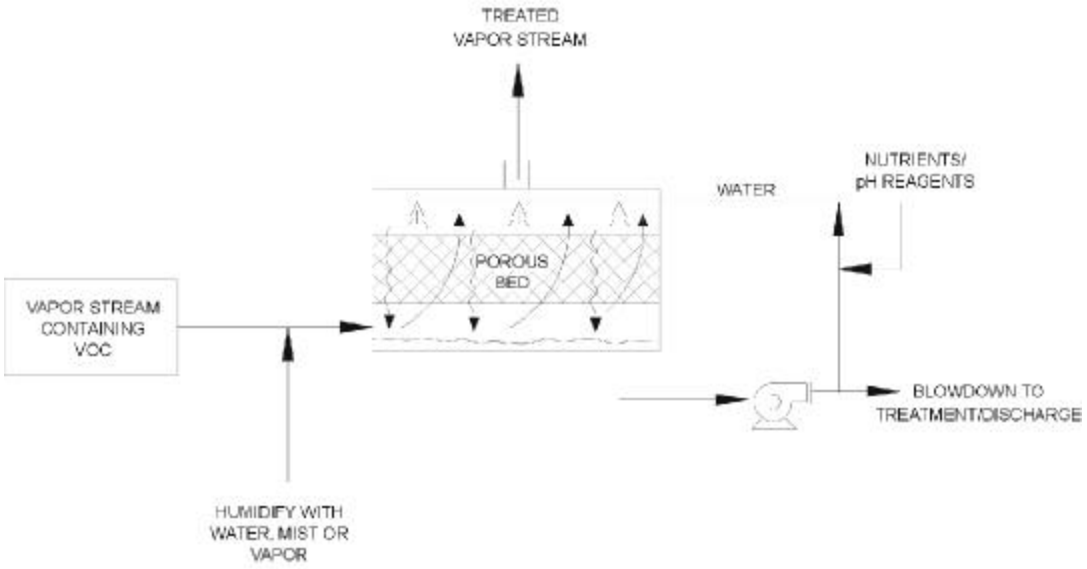

FIGURE 14-1. TYPICAL PROCESS FLOW FOR BIOFILTRATION (VAPOR)

Vapor biofiltration has been successfully used for odor control in the food industry (bakeries and breweries), for solvent vapor treatment from fiber glassing and painting operations, and for the treatment of SVE exhaust streams prior to atmospheric release.

14-3. Hazard Analysis.

Principal unique hazards associated with vapor biofiltration, methods for control, and control points are described below.

a. Physical Hazards.

(1) Confined Space.
Description: Entering process vessels and tanks for activities such as inspection, repair, and maintenance is a confined-space entry. Associated hazards include asphyxiation from the lack of oxygen, overexposure to toxic wastes and byproducts, and engulfment/entrapment by the filtration media.

Control: Controls for confined-space entry include:
- Use confined-space entry procedures for any entry activities (see 29 CFR 1910.146).
- Wear appropriate personal protective equipment (PPE), including respiratory protection (e.g., an air-purifying respirator with organic vapor cartridges) or supplied air, as needed.

- Use the Buddy System for such operations.

CONTROL POINT: Operations, Maintenance

(2) Electrocution.
Description: Workers may be exposed to electrical hazards when working around biofilters. If permanent and temporary electrical equipment that is not ground-fault protected contacts water or other liquids, an electrocution hazard exists.

Control: Controls for electrocution include
- Verify that drawings indicate the hazardous area classifications as defined in NFPA 70-500-1 through 500-10.
- Use controls, wiring, and equipment that meet the requirements of EM 385-1-1, Section 11.G and NFPA 70 for the identified hazard areas.
- Use grounded or GFIC-protected equipment if required by EM 385-1-1, Section 11 or NFPA 70 requirements.
- Permit only trained, experienced workers in equipment areas.

CONTROL POINT: Design, Construction, Operations, Maintenance

(3) Treatment Buildings.
Description: Permanent or semi-permanent treatment buildings may present life safety hazards such as inadequate egress, fire suppression systems, and/or emergency lighting systems.

Control: Controls for treatment buildings include
- Meet the following construction requirements for permanent and semi-permanent treatment system buildings: ANSI 58.1: Minimum Design Loads for Buildings and Other Structures; the National Fire Code; the National Standard Plumbing Code; Life Safety Code; and the Uniform Building Code.
- Comply with either the Air Force Manuals on Air Force bases, the USACE Technical Manuals on Army installations, or local building codes on Superfund, BRAC, or FUDS project sites.

CONTROL POINT: Design, Operations

(4) Predesign Field Activities.
Description: Predesign field activities associated with subsequent construction may include surveying, biological surveys, soil gas surveys, geophysical surveys, trenching, drilling, stockpiling, contaminant groundwater sampling, and other activities. Each of these field activities may expose the survey personnel to physical, chemical, radiological, and biological hazards.

Control: Controls for hazards resulting from predesign field activities include

- Prepare an activity hazard analysis for predesign field survey activities. EM 385-1-1, Section 1.A provides guidance on developing an activity hazard analysis.
- Train workers in hazards identified.

CONTROL POINT: Design

b. Chemical Hazards.

(1) Additives.

Description: Biological activity of the biofilters may be enhanced with the addition of nutrients or other chemical agents. These agents may include nutrients (e.g., ammonia nitrate, urea) or other chemicals (e.g., hydrochloric acid, sodium bicarbonate). Workers may be exposed to these chemicals during their application. Acute overexposure symptoms may include eye, skin, and respiratory tract irritation.

Control: Controls for additives include

- Consult chemical manufacturers' Material Safety Data Sheets (MSDS) for potential hazard information and controls including appropriate PPE and train workers accordingly.
- Use recommended PPE (e.g., an air-purifying respirator with organic vapor cartridges) during the application or blending processes.
- Design mechanical addition systems to minimize exposure.

CONTROL POINT: Design, Operations, Maintenance

(2) Fire or Explosion.

Description: Storage of the materials may cause fire or explosion if these materials are spilled and allowed to mingle with incompatible chemicals.

Control: Controls for fire or explosion include

- Store incompatible materials separately or in secondary containment.
- Consult the manufacturer or the Material Safety Data Sheets for incompatibilities.

CONTROL POINT: Design, Operations, Maintenance

c. Radiological Hazards.

No unique hazards are identified.

d. Biological Hazards.

Pathogenic Microbes.
Description: Biofilters may expose workers to pathogenic microbes, especially during maintenance or repair activities where the reactor may need disassembly or when workers are required to enter the biofiltration vessels. Inhalation of pathogenic microbes may cause allergic reactions or illness. During support media handling activities, workers' hands may be exposed to the microbes and result in accidental ingestion of pathogenic material.

Control: Controls for pathogenic microbes include

- Install partitions or barriers to contain the mist.
- Use HEPA (N100, R100, P100) filter-equipped air-purifying respirators.
- Minimize skin exposure with PPE such as gloves (e.g., butyl rubber) and chemically-resistant disposable coveralls.
- Practice good decontamination by thoroughly washing hands and face before exiting the work area.

CONTROL POINT: Design, Maintenance